Non-genetic data are not consistent with sub-divisions of J and O stocks common minke whales around Japan

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ABSTRACT

Wade *et al*. (2010) reviewed non-genetic biological information relevant to the stock structure of common minke whales in the Yellow Sea, Sea of Japan and western North Pacific. Results of their review were considered by Wade and Baker (2010) in the context of structure hypotheses of the J and O stocks. This exercise derived in the proposal of a hypothesis on stock structure (stock structure Hypothesis III) which includes the following components: i) different J stocks in the western and eastern side of Japan; and ii) different O stocks in coastal and offshore areas of the Pacific side of Japan. The non-genetic information used by Wade and Baker (2010) was re-examined to investigate the consistency of such information with those components of Hypothesis III. We concluded that the available non-genetic data is not consistent with the proposed sub-division of the J and O stocks.

KEYWORDS: COMMON MINKE WHALE, WESTERN NORTH PACIFIC, STOCK STRUCTURE, NON-GENETIC DATA, RMP *IMPLEMENTATION*

INTRODUCTION

Wade *et al*. (2010) reviewed non-genetic biological information relevant to the stock structure of common minke whales in the Yellow Sea, Sea of Japan and western North Pacific. Results of their review were considered (in conjunction with genetic information) by Wade and Baker (2010) in the context of structure hypotheses of the J and O stocks. This derived in the proposal of stock structure Hypothesis III, which involves the following components: i) different J stocks in the western and eastern side of Japan (JW and JE stocks); and ii) different O stocks in coastal and offshore areas of the Pacific side of Japan (OW and OE stocks).

In the context of the RMP *ISTs* of western North Pacific minke whales, stock structure hypotheses that are different from the two-stock hypothesis (J and O) have been considered by the IWC SC in the past, starting with the O and J sub-stock scenario proposed in 1993 (IWC, 1994). Later in 2003 another stock scenario was proposed based on the Boundary Rank Method, which suggested division of the O stock into Ow and Oe at 147°E (IWC, 2003). Discussion of those alternative stock structure scenarios and the analytical methods involved used a considerable amount of the IWC SC time. Further a considerable amount of effort was made to accommodate such scenarios in the structure of trials. Later, however, those alternative stock structure scenarios proved not plausible scientifically and they were not considered further.

The two components of the new Hypothesis III (JW/JE and OW/OE) proposed at the 2010 *pre-implementation assessment* have produced considerable disagreement among IWC SC members. Furthermore a considerable amount of work is required to accommodate such complex hypothesis in the structure of the trials. Before embarking further in this process it is important to evaluate the evidence used in support of the two components of this hypothesis.

The objective of his paper was to evaluate the consistency of the non-genetic data with the components of this hypothesis mentioned above: i) different J stocks in the western and eastern side of Japan (JW and JE stocks); and ii) different O stocks in coastal and offshore areas of the Pacific side of Japan (OW and OE).

RESULTS

JW and JE stocks

The information mentioned by Wade and Baker (2010) as supporting the hypothesis of different J stocks on both sides of Japan are conception date, flipper color and morphometric (Table 1 of Wade and Baker, 2010).

Conception date

Utility of this marker for stock structure

Conception date can be considered a useful indicator of stock structure as differences in this life history parameter have agreed well with genetic difference between North Pacific minke whale stocks.

A summary of the information on conception date in minke whales is as follow. Wada (1984) showed gene frequency differences between whales from Korean and Japanese Pacific coastal areas. Wada (1991) found that pregnant females in sub-area 11 in April with large foetuses of 60 cm or more were very close to whales from Korean waters. Best and Kato (1992) examined foetal length data and suggested two groups that are effectively reproductively separated from each other by conception seasons six month apart. Kato (1992) found two groups of different conception dates, autumn and winter. Based on the foetal length reported by Matsura (1936) and Omura and Sakiura (1956) in the Sea of Japan and Wang (1985) in the Yellow Sea, Kato (1992) estimated that these animals were autumn conceptions. On the other hand, animals from sub-area 7 were winter conception. Kato (1992) reported that his foetal analysis agreed well with the Wada (1991)'s results in sub-area 11 where two groups were mixed. These results showed that minke whales in the Sea of Japan were autumn conception while these in Pacific waters were winter conception.

Wade and Baker (2010) noted that the sample from the Sea of Japan used in Kato (1992) (n=8) appear to have a bimodal distribution of conception dates, with peaks in both autumn and winter in contrast to the samples in sub-area 7 which have only winter conception date.

Consistency of the information with sub-structure of the J stock

Differences in conception date found in past studies were attributed to geographical differences e.g. differences between animals in the Sea of Japan and Pacific side of Japan. Recently genetic studies based on microsatellite (Kanda *et al*., 2009) have allowed the assignment of minke whale individuals to stock of origin then differences in conception dates can be interpreted not only under geographical criteria but also under stock of origin.

Bando *et al*. (2010a) examined conception date of minke whales sampled by JARPN and JARPN II in the Pacific side of Japan based on genetically-identified J and O stocks. First they confirmed that minke whales genetically identified as J and O stocks have different conception dates. Therefore differences in conception dates can be attributed to differences between the J and O stocks rather than differences within each of those stocks. Second in the sample of J stock from the Pacific side of Japan, Bando *et al*. (2010a) found whales with both conception dates, a similar pattern as in the sample of 8 individual examined by Kato (1992) in the Sea of Japan. Therefore the most appropriate interpretation for the 'bimodal' pattern noted by Wade *et al*. (2010) for the Sea of Japan sample is that the span of conception dates in the J stock is larger than previously thought.

Given these results for genetically identified minke whale individuals the differences in conception dates between Sea of Japan and Pacific side whales can be attributed to differences between J and O stocks, rather than differences between J stock animals.

Flipper coloration

Validity of this marker for stock structure

Flipper color can be considered a useful indicator of stock structure as differences in this character have agreed well with genetic difference between North Pacific minke whale stocks.

Consistency of the information with sub-structure of the J stock

Differences in flipper coloration pattern found in past studies were attributed to geographical differences e.g. differences between animals in the Sea of Japan and Pacific side of Japan (Kato *et al*., 1992). As noted above recently genetic studies have allowed the assignment of minke whale individuals to stock of origin, then differences in flipper coloration can be interpreted not only under geographical criteria but also under stock of origin.

Kanda *et al*. (2010) conducted a new analysis on flipper color and tail color patterns in the Pacific side of Japan. Samples from sub-area 7W were classified into J and O stocks based on microsatellite analyses (Kanda *et al*., 2009). The study showed that the color type composition was different between the J and O stocks for both flipper and tail. No heterogeneity was found within the sample of O and J stocks.

Wade and Baker (2010) noted that 'the proportions seen in the flipper color type in the Sea of Japan whales were significantly different from the proportions seen in the Sanriku catches, which could also indicate differences between coastal whales on either side of Japan'. The most recent analyses for genetically identified whales suggested that differences in flipper color pattern can be attributed to differences between the J and O stocks rather than differences within each of those stocks.

Morphometric

Validity of this marker for stock structure

Morphometric can be considered a useful indicator of stock structure as differences in this character have agreed well with genetic difference between North Pacific minke whale stocks.

Consistency of the information with sub-structure of the J stock

Differences in morphometric found in past studies were attributed to geographical differences e.g. differences between animals in the Sea of Japan and Pacific side of Japan (Omura and Sakiura, 1956; Ohsumi, 1983; Kato *et al*., 1992). Recently genetic studies have allowed the assignment of minke whale individuals to stock of origin then differences in morphometrics can be interpreted not only under geographical criteria but also under stock of origin. Hakamada and Bando (2009) examine ten external measurements of mature minke whales sampled by JARPN II in sub-areas 7, 8 and 9 between 2000 and 2007. In this data set 118 animals were identified as O stock while two animals as J stock. Significant differences between J and O stocks were found in five of the external measurements used. No significant differences were found among O stocks animals in those sub-areas.

Given these results for genetically identified minke whale individuals, differences in morphometrics between Sea of Japan and Pacific side whales can be attributed to differences between J and O stocks, not to differences within J stock.

In summary in the past different authors showed differences in conception date, flipper color and morphometric between minke whales from both sides of Japan. All these authors attributed such differences to differences between J and O stocks. More recent analyses of those characters were based on genetically identified individuals. Results of these recent analyses showed that such differences are attributed to J and O stocks rather than differences within each of those stocks.

Our conclusion is that non-genetic data provide no evidence to support different J stocks on both sides of Japan.

OW and OE stocks

Wade and Baker (2010) concluded that the following information support the hypothesis of different O stocks in the Pacific side of Japan (OW and OE): cookie cutter shark-induced scars, contaminants, whale density and feeding grounds (Table 1 of Wade and Baker, 2010).

Cookie cutter shark-induced scars

Validity of this marker for stock structure

This ecological marker can be considered a useful indicator of stock structure as differences in prevalence have agreed well with genetic difference between North Pacific minke whale stocks. It is known that this shark might not be distributed in the Sea of Japan while it is widely distributed in the Pacific Ocean. This means that scars might be useful for distinguishing whales from these two oceans basins. However we have no information on the distribution and abundance of cookie cutter sharks in the Pacific Ocean. Goto *et al*. (2009) also noted that the number of scars depend on age and latitudes.

Consistency of the information with sub-structure of the O stock

Wade *et al*. (2010) conducted some additional analyses based on Goto *et al*. (2009) data and sought that the apparent differences found in cookie cutter shark scar prevalence in the Pacific side of Japan was supportive of differences within O stock. However the simple comparison of the number of scars is not a strong evidence to support such hypothesis.

Bando *et al*. (2010b) examined cookie cutter shark-induced scars in minke whales taken by JARPN II between 2002 and 2007. They grouped their samples according to the new sub-areas defined by the Preparatory Meeting and assigned whales to J and O stocks according the microsatellite criteria. A total of 862 O stock animals and 97 J stock animals were used in the analysis. Three type of scar occurrence were used: Type 1: none; Type 2: 1-20 scars and Type 3: more than 20 scars.

All O stock animals had scars and Type 3 predominated in this stock. The occurrence of scars in J stock animals was much less frequent and Types 1 and 2 predominated in this stock. In both stocks the number of scars increases with body length.

Bando *et al*. (2010b) compared the percentage of scars in O stock animals between sub-areas 7CN+7CS and 7E+8+9, by body length classes. The pattern observed was very similar between sub-areas with Type 3 increasing with body length.

Our conclusion is that this ecological marker provides no evidence for sub-division of the O stock into OW and OE.

Contaminants

<u>Validity of this marker for stock structure</u>

This ecological marker could be a useful tool to examine stock structure. However a correct interpretation requires information of the behavior of the particular contaminant in the environment and accumulation pattern in whales according to age of the animals. This means that simple comparison of pollutant accumulation level between sub-areas is not useful for stock identification purposes.

<u>Consistency of the information with sub-structure of the O stock</u>

Wade *et al*. (2010) reviewed the information on contaminants in the studies of Fujise (1996), Yasunaga *et al*. (1999), Nakata *et al*. (2000), Fujise *et al*. (2000), Yasunaga and Fujise (2009a;b). On the basis of their review they concluded that the information was consistent with differences in the case of the Pacific side of Japan. In particular they considered that differences in Hg level between 7, 8 and 9 support the occurrence of different O stocks.

Level of contaminants in whales depends exclusively on foods consumed and on the age and sex of the animals. Yasunaga and Fujise (2009a) had a different interpretation of their results. They considered that yearly changes in accumulation level of Hg in sub-area 9 reflect change in food habit rather than changes in accumulation levels of Hg in the environment.

Apart from this the difference in contaminants levels noted by Wade *et al*. (2010) was found between sub-areas 7+8 and 9, and therefore this observation is not consistent with the hypothesis of OW and OE in hypothesis III as putative stock OE occupies sub-areas 7E, 8 and 9.

Our conclusion is that this ecological marker provides no evidence for sub-dividing the O stock into OW and OE.

Whale density

<u>Validity of this marker for stock structure</u>

Differences in whale density index is not a strong argument to support stock differentiation as density of whales within a single stock can change spatially and temporally according to oceanographic conditions, which in turn determine the occurrence of prey species. Therefore whale density might depend on prey species distribution. In the case of North Pacific minke whales, density also depends on the segregation pattern e.g. adult males distribute widely from coastal to offshore waters while juveniles tend to distribute in the coastal waters in sub-area 7, in addition to adult males (Hatanaka and Miyashita, 1997).

<u>Consistency of the information with sub-structure of the O stock</u>

Wade *et al*. (2010) reviewed the information on minke whales density in the Pacific side of Japan reported by the JARPN review workshop (relative density by longitude across the JARPN sub-areas) and Konishi *et al*. (2009) (NPMR model in the JARPN II sub-areas). On the basis of this review they concluded that differences in whale density support the occurrence of different O stocks in coastal and offshore areas in the Pacific of Japan.

The hiatus found by the JARPN review workshop and Konishi *et al*. (2009) at 147^{O}E (which is referred by Wade *et al*., 2010) can be explained by incomplete survey as this longitude relates to the boundary of the Russian EEZ, where Japanese vessels can not conduct surveys. Furthermore Okamura *et al*. (2001) investigated the spatial and temporal structure of the minke whale distribution based on JARPN sightings data and GAM. The authors concluded that the monthly transition of the density distribution suggested the northward seasonal feeding migration of the minke whale as suggested by Hatanaka and Miyashita (1997).

Anyway it should be noted that the hiatus noted by Wade *et al*. (2010) at 147^{O}E is not consistent with the specification of Hypothesis III as both OW and OE stocks distribute west of this line according to this hypothesis.

Our conclusion is that whale density provides no evidence for sub-dividing the O stock into OW and OE.

Feeding grounds
The occurrence of whales in different grounds is not a strong argument to support stock differentiation as whales from a single stock can occupy different feeding grounds and perhaps the best example of this is the North Atlantic humpback whale.

We concluded that the non-genetic information hardly support the existence of different O stocks in the Pacific side of Japan.

DISCUSSION AND CONCLUSIONS

As noted earlier the examination of several lines of evidences is a common good practice for the investigation of stock structure. However before concluding on stock structure hypotheses, the relative utility of each piece of information for investigating stock structure should be evaluated. Furthermore a temporal and spatial segregation by sex and maturity stage is well documented for both North Pacific common and Antarctic minke whales. This characteristic of the species should be taken into account in the interpretation of non-genetic information in the context of the stock structure.

Wade and Baker (2010) interpreted the results of non-genetic information under two scenarios: two stocks (J and O) which mix to each other in the Pacific side of Japan; and two J and two O stocks They considered the latter interpretation as the most plausible, which derived in the proposal of Hypothesis III with the two components mentioned above. However they provided no direct scientific evidences of why they considered more plausible the hypothesis of two J stocks and two O stocks. Our conclusion is that the non-genetic data examined just confirm the differentiation between O and J stocks and mixing of these two stocks in the Pacific side of Japan and that those data do not support sub-structures within O and J stocks. The analyses of non-genetic markers based on genetically differentiated O and J stock samples have been particularly useful to get this conclusion.

We considered that in their proposal of sub-division of J and O stocks Wade *et al*. (2010) and Wade and Baker (2010) a) interpreted the phenomenon of segregation within a stock as differences between stocks; b) attributed evolutionary scale differences in some characters between J and O stocks to differences within J and O stocks, which is much less plausible; c) did not consider information of mixing of O and J stocks in the Pacific side of Japan; d) did not consider the interpretations given by the authors of the original papers consulted.

We believe that two components of Hypothesis III (JW/JE and OW/OE) are not supported by the non-genetic data.

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